Introduction to Logic (PHL 120)

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Course Description

Consider the following argument:

(1) **If** I become a professional philosopher, I will be poor.
(2) **If** I do **not** become a professional philosopher, I will be poor.
(3) I will **either** become a professional philosopher **or** I won't.

with the conclusion:

(C) I will be poor.

If (1-3) are all true, then the C *must* also be true. Moreover, the fact that C must be true if (1-3) are has nothing to do with the meaning of the non-bolded words in the above.[1] Compare:

(1) **If** Jack went to the store, he purchased mustard.
(2) Jack went to the store.

With the conclusion:

(C) Jack purchased a condiment.

If (1-2) are true, C *must* also be true, but this involves facts about what 'mustard' and 'condiment' mean. We can abstract from these sorts of facts and talk only about the *logical form* of sentences. We can give the form of an argument by ignoring the particular meaning of the non-logical (here, non-bolded) expressions. We will study *logical form* by theorizing about a small class of *logical expressions* such as 'if, 'not', 'or', and so on. Once we have an account of logical form, we can study *logical consequence*, or the relationship that holds between premises and conclusion of an argument where the truth of the conclusion is guaranteed by the truth of the premises *in virtue of logical form*.

Formal languages allow us to precisely model the *logical form* of arguments and systems of proof for these language enable us to demonstrate that some sentence *follows from* some other sentences *in virtue of logical form*. Learning to "translate" natural language arguments into these formal languages and to do proofs thus gives us tools to recognize the underlying formal properties of natural language, honing our sense of what follows from what and giving us an answer, sometimes, to why something follows from something else. To study *logical form* and *logical consequence*, we will construct formal languages in which to represent natural language and collections of rules for constructing *proofs* that certain sentences in our formal language are logical consequences of some other sentences.

1 Well, almost nothing. The non-bolded words have to be *grammatically appropriate*.

We will construct two different formal languages. The first, the *sentential calculus*, is a simple formal language adequate to formalize arguments like the example above. However, it is incapable of representing boring arguments like:

> (1) Everyone who has a sister has a sibling.
> (C) Everyone without a sibling does not have a sister.[2]

as well as exciting arguments like:

> (1) Every long-tailed marmot is an animal.
> (C) Every tail of a long-tailed marmot is the tail of an animal.

To represent these sorts of arguments, we will need a more expressive formal language. This new language, the *predicate calculus*, is adequate to represent a very wide class of arguments in natural language. Learning to do proofs in predicate logic will give us a very powerful tool for showing something argued for to be a logical consequence of what it is argued from. We will also learn how to demonstrate in many cases that a conclusion is not a logical consequence of some premises by generating intuitive counterexamples.

As we familiarize ourselves with these formal languages we will see—though usually not prove—how they relate to the sort of arguments we give in natural language and to the relationship of logical consequence we want to represent. Serious results in this vein such as *soundness*, *completeness*, and *compactness* will be discussed although the proofs will have to wait for a further course.

Homework

Learning to "speak" a formal language is not entirely dissimilar from learning to speak a new natural language. It is essential to practice formalizing natural language sentences and to construct proof after proof after proof. The more exercises you do, the better off you will be. I will thus assign a lot of practice problems each week. I will not grade every problem (though you will not know in advance which problems I will grade.) You are expected to write up your own solutions, but I have no objection to you discussing *how* to solve a problem with classmates ***before*** writing up your homework.

The assessment for this course will consist of 9 homework exercises and 3 take-home exams. Expect to have either homework or a take-home exam due at the beginning of the first class each week. Late homework will not be accepted except under extreme and verifiable circumstances. Instead, I will drop the lowest two scores on the homework exercises, averaging the rest. The 3 take-home exams will be difficult and time-consuming. I ***do not recommend*** waiting until the last minute to start working on them. Rather, after the take-home exams are distributed, read through them carefully and allow yourself time to work through possible solutions to the problems before attempting to solve them in a final form.

Your grade for the course will be broken down as follows: Homework problems (30%), take-home exams (60%), and class participation (10%). I will occasionally distribute extra-credit problems during class. Those not attending will miss such opportunities in addition to their class participation grade suffering.

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2 For a fun initial exercise, try to figure out which word(s) in this argument should be bolded.

Textbook

All material you will be expected to know will be covered in class, but there are a pair of textbooks which will be helpful for reminding yourself of various details and for additional exercises. For this purpose, we will use Howard Pospesel's two books: *Propositional Logic* and *Predicate Logic*. I will supplement these with handouts throughout the course. If you miss a class, be sure to email me to get the handout(s) and assignments that you may have missed.

Rough Schedule (subject to revision)

August 30th	Introduction
Week 1:	More introduction; sentential connectives
Week 2:	Sentential connectives; truth-tables;
Week 3:	Translations; finding counterexamples;
Week 4:	Sentential proofs; first take-home exam distributed
Week 5:	Proofs, proofs, and more proofs; first exam due
Week 6:	Inadequacy of the sentential calculus; quantifiers
Week 7:	Proofs in the predicate calculus
Week 8:	More on proofs in the predicate calculus; relations
Week 9:	Nested quantifiers; interesting proofs; second take-home exam distributed
Week 10:	Identity; second take-home exam due.
Week 11:	Interesting translations
Week 12:	Finding counterexamples in the predicate calculus
Week 13:	More on proofs in the predicate calculus
Week 14:	Basic Metatheory; final take-home distributed
Finals Week:	Final take-home due

College Policies

The course will adhere to throughout to all binding TCNJ policies, including with respect to Attendance (http://www.tcnj.edu/~academic/policy/attendance.html), Academic Integrity (http://www.tcnj.edu/~academic/policy/integrity.html), and the Americans with Disabilities Act (http://policies.tcnj.edu/policies/viewPolicy.php?docId=8082).